State Environmental Health Indicators Collaborative (SEHIC)
Asthma Indicators Workgroup "Lessons Learned" Summary Report

A. Introduction

This report summarizes the SEHIC Asthma Indicators Workgroup's process and lessons learned from the development and pilot-testing of two chronic respiratory disease-related indicators of population health that are known to be related to environmental conditions: Asthma Hospital Admissions and Chronic Lower Respiratory Disease (CLRD) Mortality. The CLRD mortality indicator also included asthma deaths.

The burden of chronic respiratory disease in the U.S. population is enormous. In 2004, 22.5 million people in the U.S. reported currently having asthma; and, there were over 4,055 deaths in which asthma was the underlying cause (1). Asthma is the leading chronic health condition among children, and large racial, income, and geographic disparities in poor asthma outcomes have been observed (2). Also, in 2004, there were 497,000 hospitalizations for asthma, contributing to the large direct ($14.7 billion) and indirect ($5.0 billion) costs for this disease every year (3).

Based on the International Statistical Classification of Diseases and Related Health Problems, tenth revision (ICD-10), asthma is one of the diseases classified as a chronic lower respiratory disease (CLRD), a category which also includes emphysema and chronic bronchitis, together known as chronic obstructive pulmonary disease (COPD), and bronchiectasis, all of which are characterized by impaired lung function. In 2002, more than 124,800 people died of CLRD in the U.S., and in 2000, 119,000 deaths were attributed to COPD, making COPD the 4th leading cause of death in the U.S. (4). Over 10.7 million adults in the US reported having a diagnosis of COPD in 2003 and it is estimated that there are as many or more cases that are undiagnosed. The National Heart, Lung, and Blood Institute estimate is that COPD will cost the U.S. $42.6 billion in 2007. (5)

Given the large burden of respiratory disease on the US population, the contribution of environmental risk factors to that burden should be monitored because preventive efforts in this area may potentially have a large public health impact.

B. Selection of Indicators and Measures

In order to track respiratory disease occurrences that may be related to environmental factors, we chose to measure asthma hospitalizations and CLRD/asthma mortality. These particular measures were selected because: 1) many epidemiologic studies have reported associations between air pollution exposures and respiratory disease hospitalizations and deaths; 2) the data sources are nationally standardized and available to state health departments; and, 3) preventive actions are available to address these outcomes. These indicators may also be used to identify sensitive populations.

<u>Indicator #1: Asthma Hospital Admissions</u>

Many acute asthma events, including hospitalizations and mortality, may be preventable if asthma is managed according to established guidelines, which include recommendations for reducing exposures to environmental triggers. The relationship between ambient air particulate matter (PM) concentrations and increased asthma hospital admissions is well documented. Statistical models demonstrate 5-20% increases in respiratory-related hospital admissions per 50 g/m^3 of PM_{10} and 5-15% per 25 g/m^3 of $PM_{2.5}$ or $PM_{2.5-10}$, with the largest affect on asthma admissions (6). In the Eastern United States, summer ozone pollution was associated with more than 50,000 hospital admissions per year for asthma and other respiratory emergencies. Large multi-city and individual city studies found a positive association between ozone and total respiratory hospital admissions, including asthma, especially during the warm season. Among US and Canadian studies, the ozone-associated increase in respiratory hospital admissions ranged from 2-30% per 20 ppb (24 hour), 30 ppb (8-hour) or 40 ppb (1-hour) increment of ozone in warm seasons (7).

In 2000, the Institute of Medicine (IOM) cited sufficient evidence to conclude that allergens produced by cats, cockroaches and house dust mites caused asthma exacerbations as did exposure to environmental tobacco smoke (ETS) in preschool aged children (8). A 2005 California Air Resources Board report noted that there is sufficient evidence to conclude that ETS causes asthma exacerbations in children and adults (9). That report also estimated 202,300 excess childhood asthma episodes occur each year in the U.S. as a result of exposure to ETS.

If sufficient temporal and geographic detail is available, asthma hospitalization data may signal environmental impacts, aid in identifying high-risk populations and help target interventions.

Description of measure and data sources

The data source for this indicator is state hospital discharge data. The denominator for rates is the population estimates from the U.S. Bureau of the Census and/or a state-mandated population data source, if the former is unavailable or less accurate than state Vital Statistics data. Specific measures include monthly and annual numbers of hospital admissions among residents of the state, from which the annual age-adjusted rate of hospitalizations is calculated. We also chose to measure the minimum and maximum daily numbers of hospital admissions to capture the range of variation and allow for exploration of trends (e.g. by season). These analyses were completed at this lower temporal resolution.

This indicator captures all hospital admissions and does not exclude duplications (multiple admissions by the same patient in the same year). The use of this patient selection criterion is necessary because each hospitalization is an event that may potentially be examined in relation to ambient air quality data. The indicator does, however, exclude transfers from another health care facility or nursing home.

Limitations of the measure

Several restrictions to these data are notable. Access to hospital discharge data can differ from state to state and are limited to those data voluntarily reported by participating hospitals; reporting of hospitalization data is not required in most states. Some states do not have date of admission information and geographic information is generally limited to zip code of residence. Residents of one state may be hospitalized in a neighboring state and not captured in hospital data for the state where an exposure occurred. Some additional limitations of the data source include the omission of Veteran's Administration, Indian Health Service and institutionalized (prison) populations. Practice patterns and payment mechanisms may affect diagnostic coding and decisions by health care providers to hospitalize patients.

As with all health outcome indicators, other population level risk factors should be taken into consideration. Asthma hospitalization rates are known to be strongly determined by access to primary health care and tend to be higher in areas where primary care is either unavailable or underutilized.

Indicator #2: CLRD/Which Includes Asthma Mortality

Increases in short-term exposures to ambient air PM, either 2.5 or 10, have been associated with increased asthma mortality and with increased CLRD mortality, particularly in persons over age 65 (10-12). Risk factors for respiratory disease deaths include viral respiratory tract infections and exposure to allergens or environmental hazards, such as air pollution.

By design, this indicator utilizes a broad diagnostic category to capture similar lower respiratory conditions that are conceptualized to have common environmental triggers and may respond to similar intervention strategies. Analysis of CLRD deaths will enable individual states to explore patterns and trends in mortality rates for this diagnostic category. CLRD deaths can be compared to asthma-only deaths to better understand how environmental hazards contribute to mortality and to identify sensitive populations. CLRD mortality may provide a measure of the effect of intervention efforts, such as pollution reduction and occupational interventions, as well as a measure of the respiratory health impact of emergency events. When examining CLRD, which includes asthma mortality, it is most useful to interpret these measures in the context of other adverse outcomes, such as hospitalizations, and with respect to the overall prevalence within a given geographic area.

Description of measure and data sources

The specific measures chosen for this indicator include the annual number and rate of CLRD deaths, including the age-standardized mortality rate, and the annual number of asthma deaths. These data come from state death certificate files, which usually are collected and recorded by state health departments. Coding changes between 1998 and 1999 prevent direct comparison of mortality measures from 1998 or earlier with measures from 1999 or later, without the use of recommended adjustments. The denominators for

calculating rates come from the population estimates from the U.S. Bureau of the Census and/or a state-mandated population data source.

We decided not to include deaths among state residents occurring out of state in this measure because we assumed that any associated exposure would have been more likely to have taken place out of state.

Limitations of the measure

There are several important limitations to these mortality data. Causes of death listed on the death certificate and the coding of those events may be inaccurate. The coding of asthma and COPD deaths in the elderly is particularly problematic due to difficulties in diagnosis and the presence of other co-morbid conditions that can lead to coding inaccuracies. The CLRD mortality indicator combines asthma and COPD to avoid the diagnostic uncertainty (overlap) of these 2 conditions, particularly among the elderly. Another reason to use CLRD is that asthma deaths are sparse in individual states, thereby making it difficult to analyze the data. Small numbers can result in unstable and unreliable rates or estimates. It is necessary to adhere to confidentiality requirements, especially with small cell sizes.

Data on race/ethnicity is not collected in some states, and is incomplete and/or of questionable validity in other states. As mentioned in passing above, the state of residence at death may not be the state where an exposure to an environmental hazard occurred. Patients may be exposed to environmental triggers in multiple locations that transcend state borders, but death certificate information is limited to state residents.

Care must be taken when comparing data between states, and attributing CLRD or asthma mortality deaths to environmental causes, since many non-environmental factors can also affect the clinical course of these respiratory conditions. Non-environmental factors can include, but are not limited to, medical practices (e.g. medications prescribed), individual behaviors (e.g. medication compliance, smoking, avoidance of triggers), availability of health care, and co-morbidities (e.g. respiratory infections). Because COPD is a chronic disease that often progresses with age, current mortality may not reflect recent exposures, and it may be several years before reductions in exposure affect disease trends.

Pilot Testing Results

Pilot testing was used to evaluate the usefulness and clarity of the indicator templates and the how-to guides for obtaining the two respiratory indicators for asthma hospitalization and CLRD (including asthma) mortality. Preliminary results from the two pilot studies are presented in Table 1. States involved in the SEHIC Asthma Workgroup (First Pilot) and all states on the asthma epidemiology listserv hosted by the National Asthma Control Program at the Centers for Disease Control and Prevention (CDC; Second Pilot) were invited to pilot these indicators using their state data sources and to provide results and

Table 1: Results for First and Second SEHIC Asthma Hospitalization and CLRD (Asthma) Death Indicators Pilot Studies

STATE	YEAR	ASTHMA HOSPITALIZATIONS[1]		CLRD (ASTHMA) DEATHS[2]		COMMENTS[3]
		Crude	Age Adjusted	Crude	Age Adjusted	
First Pilot						
California	2004	9.1	9.3	344.2	378.9	None
Florida	2001[5]	14.4	14.5	N/A	N/A	Data were for 2001, not 2004
Georgia	2004	12.9	N/A[4]	354.0	N/A	Age cat. diff.
Kansas	2004	10.2	10.2	479.2	445.1	None
Maryland	2004	15.6	15.7	342.2	364.0	MD HSCRC data
Minnesota	2004	8.7	8.8	360.3	354.1	None
Oregon	2004	4.3	N/A	N/A	N/A	Age adjusted asthma hospitalization and CLRD data not provided
Second Pilot						
Florida	2003/2005[6]	16.9	16.7	521.8	380.2	See footnote for data years
Georgia	2005	13.3	13.8	370.8	480.0	Guides clear & specific
Kansas	2005	10.5	10.5	549.8	502.7	Instructions require careful reading
Oklahoma	2005	13.8	13.7	666.3	634.1	Dates only with month & week
Michigan	2004	15.8	15.9	N/A	N/A	Includes out-of-state hospitalizations
Wisconsin	2005	9.6	9.7	433.3	396.5	Corrected CLRD rates shown here

[1]Asthma crude and age-adjusted hospitalization rates are for 10,000 persons.
[2]CLRD crude and age-adjusted death rates are for 1,000,000 persons.
[3]Comments for first pilot study based on SEHIC Asthma Workgroup discussions. But, comments were requested from states who participated in the second pilot test.
[4]Missing data elements are represented by N/A=Not Available.
[5]All states, except Florida, used 2004 data to compute indicator results in first pilot study. Florida used 2001 data.

[6]Use of a specific year of data was not a requirement for participation in the second pilot study. With the exception of Florida and Michigan, other four states submitted 2005 data. Florida used 2003 data for the asthma hospitalization indicator. Michigan submitted 2004 data.

Feedback to the SEHIC Asthma Workgroup: SEHIC Asthma Workgroup members presented results from the multi-state pilot tests of these indicators at meetings with state public health professionals.

All states in both pilot studies are identified in Table 1. Seven states participated in the first pilot study; six states took part in the second pilot. For both pilots, there were ten different states. Years of data used were, at times, different, between the two pilot studies. All states obtained results for the two indicators using the templates and how-to guides and their own state hospitalization and mortality data.

Comments for the second pilot study were more extensive than the points raised by the SEHIC Asthma Workgroup members who participated in the first pilot study. Comment summaries for the second pilot study are included in the bottom half of Table 1. Additional information about these comments is provided below:

A few limitations with the asthma hospital admissions indicator were brought to our attention. One state using a public use hospitalization data file was not able to access the date of admission, but was only able to obtain the month and year for asthma hospitalizations, which made the calculation of minimum and maximum daily hospitalization counts impossible.

Another concern raised was about the measure of monthly asthma hospital admissions and the fact that the number of days in a month differ by month. The reviewer suggested that we standardize the counts to adjust for this. The how-to guide was subsequently revised and now advises the user to divide each month's number of admissions by the number of days in that month to get the "average number of hospital admissions per day, by month".

Another commenter noted that the data source for the asthma hospitalization indicator is a state's hospital discharge data file, and the year of the file refers to the year of discharge. Because we are basing our asthma hospital admissions indicator on date of admission rather than date of discharge, a late December admission would not be included in the file if a patient was discharged in the following year. The group decided that it was important to base our indicator on date of admission so that hospitalization events could potentially be integrated with daily air quality events.

A caveat has been incorporated into the how-to guide explaining that some late-December admissions might be missed. These missed admissions could be corrected, however, in the following year when the next year's data are received. In Minnesota, it was found that in 2004, 1% of the December hospital admissions for asthma were discharged in 2005. The median length of stay for an asthma hospitalization in

Minnesota is 2 days, so the greatest impact is expected for people admitted December 29-31.

Lastly, one reviewer identified discrepancies in what was stated in the how-to guide and what steps had to be completed to obtain indicator data and then use these state-specific measures to compute the indicator.

C. Discussion

Lessons learned of the asthma hospitalizations and CLRD (including asthma) mortality indicators can be grouped into process (subjective) and outcome (objective) levels. With regards to what is involved in indicator development—the subjective process, it is a labor-intensive activity. Many conference calls, face-to-face meetings and large time commitments were required by all group members. Initial discussions focused on determining what we wanted to measure and what data were or were not available from multiple states.

Refinement of the indicator occurred next. Group consensus had to be attained on data selection/exclusion criteria, what dependent measures should be used, variable definitions, which measures should be explored in the future and limitations in indicator measurement and use. For example, the SEHIC Asthma Workgroup devoted numerous hours discussing what age groups to use because we wanted to be consistent with the data collection, analysis, interpretation and use by the National Asthma Control Program at the CDC and the accepted practice in the utilization of the U.S. Census data and denominator data. Another fine point dealt with was the exclusion of transfers between health care facilities and out-of-state admissions.

The formatting of the template was challenging due to the need to establish consistency across the types of indicators (health data and environmental hazard data). While the initial decision by the SEHIC Asthma Workgroup was to adopt the template developed for Council of State and Territorial Epidemiologists (CSTE) occupational indicators, the three SEHIC workgroups ultimately developed a unique template that incorporates the unique attributes of both environmental hazard and health indicators.

It is important to know about the process of indicator development, and to be aware if there are differences based on the way all SEHIC indicator workgroups approached this indicator development activity. By reviewing indicator results and reading the lessons learned reports it should be possible to determine if the amount of work required also differs as a function of indicator type (and workgroup composition). This and the other two lessons learned reports from the SEHIC indicator workgroups can contribute to the better understanding of how to best develop other planned indicators.

D. Conclusion

We found that these two indicators are generally easy to generate, after the workgroup was able to agree on outcomes. Asthma hospitalization data can be utilized to examine

disease trends that occur over time and space. This information can be utilized to identify vulnerable populations and to target public health interventions (e.g. air quality alerts and programs aimed at the reduction of environmental tobacco smoke). Current clinical consensus is that most asthma deaths are preventable, when appropriate treatment is available and environmental triggers can be avoided. Intervention efforts that include the control of outdoor and indoor air pollution may further contribute to the decrease of respiratory disease exacerbations, and a reduction in total CLRD and asthma mortality.

The availability of additional details in the analysis of these measures could make these data more useful. The Asthma Workgroup recommends further analysis of these indicators by age, gender, race, and ethnicity, whenever such measures are available and the sample sizes are sufficiently large. Also of interest are co-morbidities for asthma and CLRD events, such as pneumonia, influenza and heart disease, and other underlying risk factors for hospitalizations (available from E-Codes), and deaths (V-codes).

The Asthma Workgroup plans to explore the use of data on emergency department (outpatient) visits for asthma and CLRD as an additional measure of non-fatal acute respiratory events related to environmental exposures, and will also consider the use of medication dispensing as an effect modifier on asthma hospitalizations. This SEHIC Asthma Workgroup recognizes that there will be additional challenges in developing these indicators because not all states have equal access to outpatient data and because medication use can be associated with disease management directly and access to care indirectly.

Additional evaluation is needed in order to determine whether these measures are sufficient to quantify the impact of environmental factors on respiratory disorders. Methods for integrating these indicators with air quality data are needed.

E. References

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